

WOODBURNING HANDBOOK

How to Burn More Efficiently
In Your Stove or Fireplace and
Produce Less Air Pollution

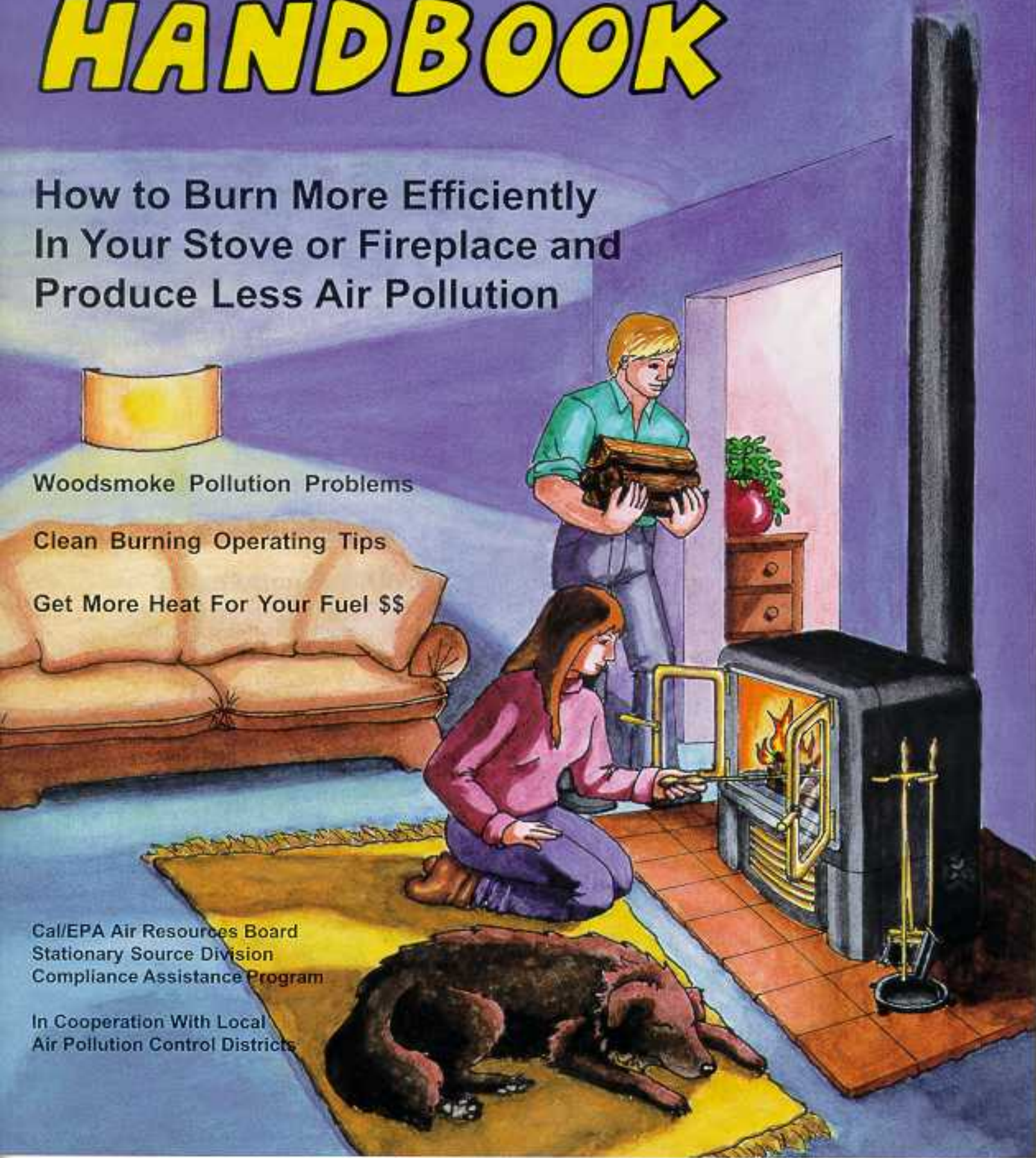
Woodsmoke Pollution Problems

Clean Burning Operating Tips

Get More Heat For Your Fuel \$\$

Cal/EPA Air Resources Board
Stationary Source Division
Compliance Assistance Program

In Cooperation With Local
Air Pollution Control Districts



What is Woodsmoke? It's AIR POLLUTION!

It's Also Fuel from Your Firewood Which Has Escaped Burning...

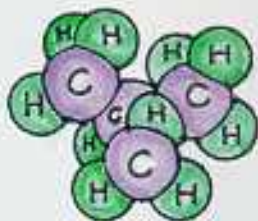
Complete combustion gives off light, heat, and the gases carbon dioxide and water vapor. Burning wood produces the above, and, because wood burns only partially in most cases, it also produces the following major air pollutants, which are regulated by State and federal rules because of their known health effects:



CO - Carbon Monoxide - Odorless, produced in large amounts by burning without enough air, **CO reduces the blood's ability to supply oxygen to body tissues**. Small amounts in the air can stress your heart and reduce your ability to exercise. Those most at risk from CO poisoning are the unborn child, and people with heart, circulatory or lung disease, or anemia.



NOx - Oxides of Nitrogen - Impairs proper functioning of the respiratory system and its ability to fight infection. NO₂ and NO also combine with VOCs to make **ozone** and with water vapor to form **acid rain** or acid fog.



VOCs - Volatile Organic Compounds - Evaporated carbon compounds (some toxic - see below) which react with NO₂ and NO in sunlight to form ozone, or photo-chemical **smog**. **Ozone injures the lungs and makes breathing difficult, especially in children and exercising adults.**

Woodburning also produces **Inhalable Particulate Matter (PM10)**, microscopic solid or liquid particles 10 microns in diameter or smaller. **Most smoke particles are VERY small droplets of condensed organic vapors (wood tars and gases), unburned fuel which escaped from the fire.** Other smoke particles include **soot** (unburned carbon) and **ash** (unburnable minerals). Most smoke particles average less than one micron (one millionth of a meter) in size, allowing them to remain airborne for weeks. When inhaled, they travel easily deep into the lungs, **causing irritation and coughing.** **Smoke PM10 particles may be trapped in your lungs for years, contributing to lung changes, chronic lung diseases, and cancer.**

Smoke Contains Toxic Pollutants

Woodsmoke also contains VOCs which have been changed in the fire into **irritating, toxic and/or cancer-causing substances** such as **benzene, formaldehyde and benzo-a-pyrene, a polycyclic aromatic hydrocarbon (PAH).** Researchers are now studying these and other smoke products to learn more about their effects on human health.



Air Pollution Sources Increase With Population...

Air pollution affects millions of Californians every day. It damages our health, our crops, our property and our environment. Vehicles and industries produce most of the air pollution in the cities. Air pollution from agricultural burning and nearby cities is carried into rural areas by wind. **But in neighborhoods everywhere across California, residential woodburning is a growing source of localized air pollution.** Most wood heaters (woodstoves and fireplaces) release far more air pollution, indoors and out, than heaters using other fuels. **Woodsmoke degrades the air quality and visibility significantly** in areas where many woodstoves and fireplaces are in use.

The Compliance Assistance Program at the California Air Resources Board and your local air district are asking you to **help clear the air of woodsmoke**. In this handbook you will find information about the air pollutants in woodsmoke, their health effects, how wood burns, why it smokes and how you can produce less woodsmoke.



You Can Make a Difference!

Take These Steps To Reduce Woodsmoke Pollution!

1. Stop Burning Wood!

- Use a cleaner, easier, maybe cheaper, fuel to heat your home (page 13).
- Convert your fireplace to gas with a new gas fireplace insert (page 6).

2. If You Must Use Wood, Burn Less Wood:

- Reduce your heating needs by weatherizing your house (page 4).
- Replace your old woodstove or fireplace with a new certified model, and get more heat & less pollution while burning less wood (page 8).

3. Change the Way You Operate Your Stove or Fireplace:

- Burn only clean, seasoned wood and nonglossy white paper (page 10).
- Build small, hot fires instead of large smoldering ones (page 10).
- Burn seasoned cordwood, densified logs (page 9), and firelogs (page 6).
- Watch your chimney for smoke (page 11).
- Follow your woodheater's operating instructions carefully (page 11).
- Inspect often, keep your woodheater and chimney in good condition (page 12).

Smoke Hangs Around in Winter...

Cold nights, with little wind - common weather conditions in the winter months when we heat our homes - often cause smoke and other air pollution to accumulate close to the ground overnight. These stagnant conditions can last for days.

This is a big problem in California valleys. As night falls, ground level air cools and cold air also slides down the valley walls, pooling on the valley floors. With little or no wind, **temperature inversions** can then occur - warm air layers act as a lid over the cold air in the valleys, trapping smoke and other air pollution close to the ground. Since home heating systems operate mainly in the evening, **the smoke from stoves and fireplaces remains at ground level and collects overnight in the air you and your neighbors must breathe. Yes, it does seep into your homes.**



Don't Smoke Your Neighbors Out!

Smoke from neighborhood stoves and fireplaces is a common source of both odor and reduced visibility, the air pollution problems that people complain about the most. These, plus the health-related problems caused by inhaling smoke pollutants, add up to significant health costs for individuals and the community. So be a good neighbor and limit your burning, and if you do burn, burn correctly. **Do Not Burn Wood When the Air Quality is Poor!**



Burning Wood Often Causes Indoor Air Pollution

High levels of smoke pollutants leaking from stoves and fireplaces have been measured in some woodburning homes. If you or a family member suffer from chronic or repeated respiratory problems or heart disease, you should not burn wood at all. If you must burn, make sure your stove or fireplace doesn't leak and that you operate it correctly. Remember, if you can smell smoke, you have a problem.



Where Does Your Heat Go?

The Importance of Insulation and Weather-stripping

Warm air is always escaping from your house, and is replaced by unheated outdoor air. The typical house has one-half to two air exchanges per hour, and more on windy and/or very cold days. If your house has little insulation thus many air leaks, you are paying to heat the outdoors. **If the outside air is smoky, soon your air inside will be, too.**

Some air exchange is necessary because of the many sources of air pollution in the home (wood heater, gas stove, consumer products, cigarettes, etc.) Sufficient fresh air inlets are needed to replace air forced out of the house by exhaust fans, the dryer, furnace, water heater, or wood fire; otherwise "backdrafting" will suck polluted exhaust air in the appliance vents back into the home. **But you can reduce your heating needs if you:**

Install Ceiling Insulation (Very Important) - because hot air rises, **much heat is lost** through the ceiling and roof. Wall and floor insulation also reduce heat loss. Recommended amounts have increased in recent years, so be sure your house has all it needs.



Caulk around all windows, doors, pipes; **any** opening into the house.

Weather-strip all door and window openings and consider installing double-paned glass, outdoor or indoor storm windows, and/or insulated curtains.

Close the damper tightly when the heater is not in use. Stoves and fireplaces allow air to leak out of the house even when they are not operating, unless they are **literally** airtight.

Close off unused rooms - don't waste the heat.

Thermal Storage can help you keep your heat longer. Brick, stone or water-filled structures located near the heater soak up heat from a fire (and from sunlight!) and release it back into the room for hours after the fire is out.

Most Fireplaces and Old Woodstoves Are Expensive Heaters Because They Turn a Large Part of Your Firewood Into Smoke, Not Heat!



Why Does This Happen? Because of the Way Wood Burns -

Wood burns **completely** only at **very high temperatures** with enough **oxygen** present. Wood, heat, and oxygen have to mix together in the same place at the same time. Although all stages of burning actually occur at the same time on a burning log, let's place a "demonstration" log on a hot fire and review the events. As the temperature rises, the log will "burn" in three stages:

1. **Boil Off Water** - moisture in the log evaporates as it heats up, and hisses and bubbles out through the log's surface as water vapor. This takes longer and **uses up lots more heat energy** if the log isn't really dry. *That heat energy could be warming your house instead of drying your wood before it will burn.*



2. **Vaporize Wood Gases** - before burning, firewood "cooks" and forms hundreds of new volatile organic gases and tars plus charcoal (carbon). The gases and tars, a large part of your fuel, vaporize in the heat and stream out of the log in a "wind" of organic gases. **They escape up the flue** because the log temperature at this stage is too low to burn them. *As they cool, some of the gases will combine with water vapor to form highly flammable oily liquid with a pungent odor, called **creosote**, that sticks to the flue walls; other gases condense into smoke particles.*



3. **Burn Log Charcoal** - above 600° F the log "catches fire" and the escaping gases start burning, ignited by near flames, but the log charcoal doesn't start to burn and emit heat until the log reaches 1000° F. **Burning the charcoal remainder of the log produces most of the fire's usable heat.** *However, it won't ignite before reaching 1100° F, and then **only** with enough **oxygen** present.*



The PM10 pollution from one old woodstove, emitting 60 grams/hour of PM10, equals that of ten U.S. EPA certified stoves (averaging 6 grams/hour PM10), or that of three thousand gas furnaces - producing the same amount of heat.

Most Fireplaces Are Not Good Heaters

Most fireplaces rob your house of heat because they draw in lots of the air you've paid to heat and send it up the chimney! Yes, you'll be warmed if you sit within six feet of the fire, but the rest of your house is getting **colder** as outdoor air leaks in to replace the hot air going up the chimney.

Most fireplaces waste wood because with unrestricted air flow, the vaporized wood gases and tars cooked out of your logs go right up the chimney as **smoke**. Air helps the fire **burn fast**, so a load of wood lasts only one or two hours.

Most fireplaces can pollute more if you install glass doors or a fireplace insert that is not a new, certified clean-burning model. Restricting the air supply reduces the available oxygen and causes the fire to smolder and smoke.



You Can Clean Up Your Air Guzzling Fireplace!

Switch to Gas. Gas fireplaces are gaining in popularity. The new models look like a real wood fire! They are self-contained units which can be fitted into your existing masonry fireplace. They send less of your heated air up the chimney.

This equipment burns cleaner, is easy to start, convenient, safe and inexpensive to operate, and is a good source of heat.



Certified Woodburning Fireplace Inserts have been developed which meet federal emission standards and provide high fuel efficiency. They are available in many sizes and styles to fit into your masonry fireplace. **They provide excellent fire viewing and heat output with very little smoke.**

Burn Manufactured Fireplace Logs. Reduce heat loss and air pollution from your fireplace by burning **firelogs**. Made of dry, fine-particle sawdust and **wax**, these "logs" burn slowly at high temperatures, producing less smoke and sending less air up the chimney. Underwriters Laboratories (UL) recently classified firelogs as safe to burn in UL listed factory built fireplaces. **However, firelogs are not recommended for use in woodstoves.**



How Much Heat You Get

The **heating efficiency** of any wood heater depends on combining two factors:

1. **How completely it burns the firewood** (combustion efficiency); plus
2. **How much of the fire's heat gets into the room**, rather than going up the flue (transfer efficiency).

How efficiently your wood heater operates depends on 2 more factors:

1. **Its installation** - located on an outside wall? Too big for house? Flue draws well?
2. **Its operation** - Wood green? Stove stuffed with wood? Fire starved for air?

Your operating techniques account for the largest variations in your woodstove's heating efficiency.

HEATING EFFICIENCY

Masonry Fireplace	-10% to 10%
Manufactured Fireplace	-10% to 10%
Freestanding Fireplace	-10% to 30%
Antique Stove	20% to 40%
Fireplace Insert	35% to 50 %
Airtight Stove	40% to 50%
Masonry Heater	50% to 70%
Certified Stoves, Inserts, Fireplaces	60% to 80%
Gas Heater	60% to 90%
Electric Heater	100%

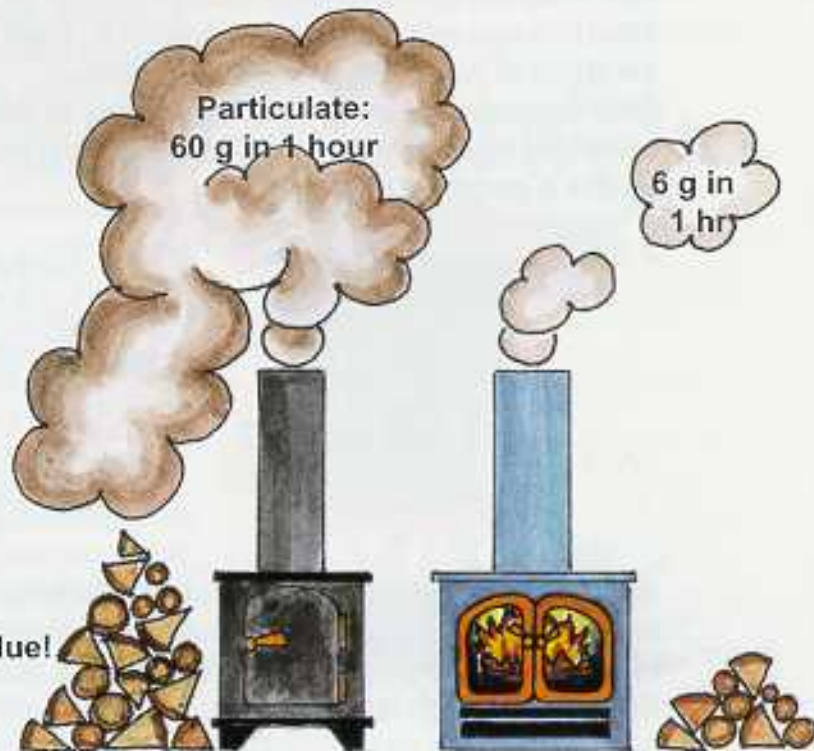
Can't Heat With Gas? Get a New U.S.EPA Certified Stove -

Old stoves waste 30% to 60% of your wood. If your woodstove is more than a few years old and is not U.S.EPA certified, you should seriously consider buying a new certified woodstove.

It will burn all of your wood, increasing combustion efficiency, producing far less smoke and creosote buildup, and reducing air pollution.

It incorporates the latest and best technology available on transfer efficiency, and will provide more heat for your house and less for your flue!

Burn two cords instead of three and get the same amount of heat!

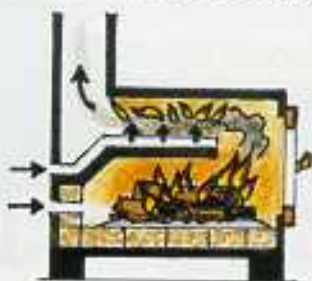


It Will Help Pay For Itself in Fuel and Cleaning Savings!

U.S.EPA Certified Woodstoves Heat More and Pollute Less

Since 1988, the manufacture and sale of new woodstoves and fireplace inserts in the US have been regulated by the U.S.EPA. Tighter standards (Phase II certification) became effective on July 1, 1990. The certified stoves heat better with less wood because **they burn more of the combustible gases that become smoke** in fireplaces and old stoves. There are three basic certified stove designs to choose from:

Catalytic Stoves - similar to the smog device on new cars, the catalytic combustor in these stoves allows the volatile gases to burn at lower temperatures. Smoke passes through a ceramic honeycomb coated with a rare-metal catalyst, which allows complete smoke combustion and heat release at 500-700°F. Their efficiency does drop over time and the catalyst device requires replacement after three to seven years of use.



Noncatalytic Stoves - these stoves are designed with baffles and/or secondary combustion chambers which route the burnable gases through the hottest part of the firebox and mix them with sufficient air to burn them more completely.

Pellet Stoves Burn Cleaner Than Wood Stoves

Pellet stoves are the most efficient and least polluting of the new stove designs, and most are exempt from certification because they provide excess combustion air. Most have some moving parts and require electricity. The pelleted fuel (compressed wood waste) automatically feeds into the firebox. A fan blows in combustion air and the fire burns hot and clean. Another fan blows room air through a heat exchanger and into the room.



Look for the U.S. EPA Label on the Stove Before You Buy!

For maximum safety and efficiency have a professional installer calculate the correct stove size for the area you want to heat, install the stove, and design and install the chimney.

Follow These Tips on Clean Burning - Heat More Efficiently and Reduce Air Pollution!

1. Burn a Mix of Softwoods, Hardwoods, Pressed Logs

Start Your Fire With Softwood Kindling

Softwoods (pine, fir) are generally low in density, ignite easily, burn fast and hot and will heat the firebox and flue quickly. They're ideal for kindling and starting your fires, but **form creosote easily** due to the high resin (sap) content.



Burn Longer and Cleaner With Hardwood and/or Manufactured Densified Logs

Hardwoods (oak, orchard) are denser and take longer to ignite, but burn slower and more evenly, producing less smoke. They also **provide more heat energy** than softwood logs the same size. **Densified logs** are compressed sawdust (no wax); at 8600 Btu/lb, they burn longer and emit 25 to 50% less PM10, CO and VOCs than burning firewood.



2. Burn Only "Seasoned" Firewood

Firewood should dry, or "season" **6 to 12 months minimum** after splitting. Hardwoods dry slower than softwoods and some may take over a year to dry. "Seasoned" firewood by definition contains 20 percent moisture or less by weight. **The warmer the storage area, and the more air circulation, the faster the drying time.**

To Speed Drying:

Split and Stack - logs dry from the outside in, so split big logs right away for faster drying. Stack loosely in a **crosswise** fashion to get good air circulation.



Store High & Dry - Stack a foot or more above the ground and away from buildings in a sunny, well-ventilated area. Cover the top to keep dew and rain off the wood, but leave the sides open to breezes.

3. Buy Wood Advertised as "Seasoned" Carefully. Look for:



- **Dark colored, cracked ends**, with cracks radiating from the center like bicycle spokes.
- **Light in weight**, meaning there's little moisture left - but hardwood logs will weigh more than softwood.
- **Sound** - hit two pieces together. Wet wood makes a dull "thud" sound. Dry wood rings with a resonant "crack," like a bat hitting a baseball.
- **Easily peeled or broken bark**. No green should show under the bark.

4. Don't Burn Anything but Clean, Seasoned Wood, Manufactured Logs, and Nonglossy White Paper

This means No Garbage, Plastics, Rubber, Waste Solvent, Paint or Oil, No Painted or Treated Wood, Particleboard, Plywood, or Saltwater Driftwood, No Coal or Charcoal Briquettes, and No Glossy or Colored Paper. **Burning these materials can produce noxious, corrosive smoke and fumes which may be toxic** and can foul your catalytic combustor, your flue, and the lungs of your family and neighbors. **Warning:** kiln-dried lumber vaporizes too rapidly, causing creosote buildup.



5. Build a Small, HOT Fire First To Preheat the Firebox & Chimney



- **Open Damper Wide** - allow inlet of maximum air to fuel the fire, and leave open to allow air inlet for 30 minutes.
- **Start Small & Hot** - leave a **thin** layer of ash for insulation. Crumple a few sheets of newspaper and add some small pieces of kindling, then light. Add bigger kindling a few at a time as the fire grows. Get it burning **briskly** to form a bed of hot coals. Now add 2 or 3 logs.
- **Position the logs carefully** - place close together to keep logs hot, but slightly apart to let sufficient air (**oxygen**) move between them.

Light & Refuel Your Fire Quickly and Carefully , As These Are The Two Times It Will Smoke the Most.

6. Refuel While the Coals Are Still Hot!

Open the draft controls and damper **one minute** **before** opening the stove door. This helps prevent backpuffing of smoke into the room.

Preheat again by placing a few pieces of kindling on the red hot coals. Add more as they catch fire. Now, add a **few** larger pieces. **Small, frequent loading causes less smoke** than a big load in most older stoves.

After refueling, leave the dampers and inlets open for about 30 minutes. The fire will get plenty of air and burn hot, retarding creosote formation (most forms early in a burn). You'll know the chimney is heated again when the new logs burn vigorously.



7. Maintain Your Fire Properly - Watch the Temperature

Don't Close the Damper or Air Inlets All the Way - the fire will smoke from lack of air.

Follow the Stove Manufacturer's Instructions Carefully. Be sure that any family member who operates the stove is also familiar with these instructions.

Your Actions Determine How Efficiently Your Stove Will Operate. A good stove is designed to burn cleanly and efficiently, but it can't do its job right if you don't cooperate.

8. Overnight Heating

DO NOT Burn Overnight - It's a major fire hazard. And it's too tempting to choke the fire for air to slow burning, and then pollute the neighborhood all night. This can also lead to backdrafting the smoke into your own home, causing very hazardous indoor air pollution.

Better to Build a Small, Hot Fire and Let It Burn Out Completely, and relying on your home's insulation to hold in enough heat for the night. **Then Close the Damper Tightly.**



9. Heating in Warmer Weather

If a small space heater won't suffice, open the air controls wide and build a **small, hot fire**, using more finely split wood, and let it burn out. Trying to reduce the heat from a big fire by reducing its air supply leads to smoldering, creosote buildup and air pollution.

10. Watch for Smoke Signals!

Get into the habit of glancing out at your chimney top every so often. Apart from the half hour after lighting and refueling, a properly burning fire should give off only a thin wisp of white steam. **If you see smoke**, adjust your dampers or air inlets to let in more air. **The darker the smoke, the more pollutants it contains** and the more fuel is being wasted.



11. Inspection and Upkeep - For Safety's Sake

Periodic **inspection** of your stove or fireplace is **essential** to ensuring its continued safe and clean-burning operation. Carefully check, and repair the following as needed:



- **Chimney Cap** - can be plugged by debris which will reduce draft.
- **Chimney** - should be cleaned professionally **at least once a year** to remove creosote buildup.
- **Catalytic Combustor** - holes can plug up; follow instructions to clean.
- **Stovepipe** - angles and bolts are particularly subject to corrosion.
- **Gaskets** - on airtight stove doors need replacement every few years.
- **Seams** - on stoves sealed with furnace cement may leak, because eventually the cement dries out, becomes brittle, and may fall out.
- **Firebrick** - may be broken or missing.
- **Grate** - or stove bottom where the fire is built which crack or break.

Remember : There is a Box With a Fire in it Inside Your House.
Creosote Can Fuel a Chimney Fire That'll Burn Your House Down

Do You PAY MORE to Heat With Wood?

The chart below shows you which woods will produce the most heat per cord (128 cubic feet of wood), and will help you compare your conventional home heating fuel to wood. Pound for pound, all woods have about the same heating value. **But hardwood logs are heavier and denser than softwood logs and burn longer, providing more heat per log.**

Firewood	Available Heat
Tree Species	(Million Btu/Cord)
	60% Efficient Stove
Alder	19
Almond	24
Apple	24
Cedar	14
Cherry	19
Eucalyptus	20
Elm, American	17
Fir, Douglas	19
Fir, White	15
Hemlock	14
Locust, Black	24
Madrone	24
Oak, Live	24
Oak, Red	21
Oak, White	23
Maple	19
Pine, Ponderosa	12
Pine, Sugar	12
Pine, White	12
Poplar	12
Redwood	12
Sycamore	18
Walnut, Black	20
Walnut, English	20
Willow	12

One Million Btu of Fuel* Equals:

293 kilowatt hours of electricity;

12.5 therms of natural gas; or

13.6 gallons of propane.

1. What Do You Pay for a Unit of Fuel?

Check Your Utility Bill For Your Unit Price.

If you pay \$0.60 per therm for natural gas, one million Btu of gas will cost you $12.5 \times \$0.60 = \7.50 .

2. What Did You Pay for a Cord of That Wood?

You just bought a cord of Almond for \$195. Almond wood has a heat value of 24 million Btu per cord, burned in a 60% efficient stove.

3. How Does Heating with Gas Compare to Burning a Cord of Almond?

You would pay $\$7.50 \times 24 = \180 for gas, \$15 less than you paid for the cord of Almond.

In most areas of California you will pay more to heat with wood than to heat with gas, and less to heat with wood than to heat with electricity.

However, if you get a new, certified stove and your new stove's heating efficiency is 80%, you can increase the **heat energy available** in each cord of wood by 20%. Using the example above, a cord of Almond burned in an 80% efficient stove would have 28.8 million Btu of heat, not just 24. You would pay $\$7.50 \times 28.8 = \216 for 28.8 million Btu of gas, or \$21 more to heat with gas than with your \$195 cord of Almond.

*Assuming an energy conversion process efficiency of 100% for an electric heater, 80% for a natural gas furnace, and 80% for a propane furnace. New model gas furnaces achieve up to 95% efficiency.

Local Woodburning Regulations

In light of growing evidence of health effects, the smell of woodsmoke no longer has the pleasant associations it once had. Some California cities and counties have enacted local ordinances to limit the growing woodsmoke problem. Mammoth Lakes, Squaw Valley, Cloverdale, Healdsburg, Petaluma, and Fresno permit installation of only U.S. EPA certified wood-fired appliances in all new construction. Mammoth Lakes bans wood-burning when the air quality is poor, and the Bay Area Air Quality Management District has adopted a similar voluntary no-burn program on poor air quality days.

Future Woodburning Regulations? Yes, Very Likely...

The California Air Resources Board has suggested the following air pollution control measures for residential woodburning. The local California air pollution control agencies are adopting these and/or other regulations as they find it necessary:

- **Implement a Public Awareness Program** encouraging cleaner woodburning practices, including information on proper operation and maintenance of wood heaters, proper wood selection and use, the health effects of wood smoke, weatherization methods for homes, and determining the proper size of the heater needed before purchase and professional installation.
- **Require Replacement of Non-Certified Wood Heaters** upon sale of any residential, commercial or industrial property before completion of escrow.
- **Restrict the Sale and Installation of Used Wood Heaters.**
- **Require Firewood Advertised For Sale as "Seasoned"** to contain no more than 20% moisture by weight.
- **Prohibit the Burning of Certain Materials** such as garbage, treated wood, plastic, rubber, petroleum products, paints, solvents, and high-sulfur coal.
- **Implement Voluntary No-Burn Days for Non-Certified Wood Heaters and Fireplaces** during periods with unhealthful air quality.

Your State and local air pollution control agencies urge you to burn clean, burn safe, and burn smart - and to choose not to burn on air quality days.

For more information contact your local building inspector, fire department, county agricultural extension office, woodstove retailer, chimneysweep, or air pollution control district office.

Need More Information?

Air Resources Board (800) 952-5588

District _____



Multi-County Districts

- 1 - Bay Area (415) 771-6000
- 2 - Feather River (530) 634-7659
- 3 - Great Basin (760) 872-8211
- 4 - Monterey Bay (831) 647-9411
- 5 - North Coast (707) 443-3093
- 6 - Northern Sierra (530) 274-9360
- 7 - South Coast (909) 396-2000
- 8 - Yolo-Solano (530) 757-3650
- 9 - San Joaquin Valley (559) 230-6000

County APC Districts

Amador (209) 257-0112	Lake (707) 263-7000	San Diego (858) 650-4700
Antelope Valley (661) 723-8070	Lassen (530) 251-8110	San Luis Obispo (805) 781-4247
Butte (530) 891-2882	Mariposa (209) 966-2220	Santa Barbara (805) 961-8800
Calaveras (209) 754-6504	Mendocino (707) 463-4354	Shasta (530) 225-5674
Colusa (530) 458-0590	Modoc (530) 233-6419	Siskiyou (530) 841-4029
El Dorado (530) 621-6662	Mojave Desert (760) 245-1661	Tehama (530) 527-3717
Glenn (530) 934-6500	No. Sonoma (707) 433-5911	Tuolumne (209) 533-5693
Imperial (760) 482-4606	Placer (530) 889-7130	Ventura (805) 645-1400
Kern (661) 862-5250	Sacramento (916) 874-4800	

© printed on recycled paper

02-018
COPYRIGHT © 2002 California Air Resources Board, PO Box 2815, Sacramento, CA
95812
Illustrations by E. Decella
<http://www.arb.ca.gov>

California Environmental Protection Agency

 Air Resources Board